

CLAIMS

What is claimed is:

1. A bimorphic polymeric photomechanical body comprising:
 - a layer of non-isotropic polymeric photomechanical material.
- 5 2. A photomechanical body comprising:
 - a first layer of a first polymeric photomechanical material; and
 - a second layer of a second polymeric photomechanical material, said second layer of a second polymeric photomechanical material affixed to said first layer of said first polymeric photomechanical material, each said polymeric
- 10 photomechanical material adapted such that illumination of said polymeric photomechanical material by an applied field of selected light energy induces a photomechanical effect producing a bulk dimensional change,
 - wherein, illumination of said first polymeric photomechanical material by an applied field of selected light energy causes a bimorphic deformation of said
- 15 photomechanical body.
3. A photomechanical apparatus comprising:
 - a photomechanical body, said photomechanical body comprising a polymeric photomechanical material, said polymeric photomechanical material adapted such that illumination of said polymeric photomechanical material by an applied field of
- 20 selected light energy induces a photomechanical effect producing a bulk

dimensional change proportional to an intrinsic property of said polymeric photomechanical material, and

wherein, said intrinsic property varies along a gradient within said polymeric photomechanical material such that said bulk dimensional change comprises a bimorphic deformation of said photomechanical body.

4. The apparatus of Claim 3, wherein said bulk dimensional change is proportional to a parametric value of said intrinsic property.

5. The apparatus of Claim 4, wherein said parametric value is the thermal coefficient of linear expansion of the polymeric photomechanical material.

10 6. The apparatus of Claim 3, wherein said applied field of selected light energy comprises an applied spectrum of light energy selected from the visible and infrared light spectrum.

7. The apparatus of Claim 6, wherein said applied spectrum of light energy comprises a discrete spectrum of light energy selected from the visible and infrared light spectrum.

8. The apparatus of Claim 6, wherein said applied spectrum of light energy comprises a continuous spectrum of light energy selected from the visible and infrared light spectrum.

9. The apparatus of Claim 3, wherein said applied field of selected light energy 20 comprises an applied spectrum of light energy selected from the light spectrum between 300 nm and 10000 nm.

10. The apparatus of Claim 3, wherein said photomechanical polymeric material comprises a photosensitive polyvinylidene fluoride.

11. The apparatus of Claim 10, wherein said photosensitive polyvinylidene fluoride comprises a bimorphic polyvinylidene fluoride film.

5 12. The apparatus of Claim 11, wherein said bimorphic polyvinylidene fluoride film comprises a polyvinylidene fluoride film coated with a light absorbing material.

13. The apparatus of Claim 3, wherein said photomechanical polymeric material comprises a photosensitive mylar.

14. The apparatus of Claim 3, wherein said photomechanical body comprises a
10 structure formed from said polymeric photomechanical material, said structure selected from the group comprising an elongated plate, a thin sheet, a fiber, and a wound strand.

15. The apparatus of Claim 4, wherein said photomechanical body comprises an elongated plate, said elongated plate comprising a first plate layer of a first
15 polymeric photomechanical material and a second plate layer of a second polymeric photomechanical material,

wherein, said first plate layer is affixed upon said second plate layer,
wherein, said first polymeric photomechanical material comprising said first plate layer has a first plate layer average parametric value of said intrinsic property
20 along said gradient and said polymeric photomechanical material comprising said

second plate layer has a second plate layer average parametric value of said intrinsic property along said gradient, and

wherein, said first plate layer average parametric value is greater than said second plate layer average parametric value.

5 16. The apparatus of Claim 3, wherein said photomechanical effect produces an elastic bulk dimensional change within said polymeric photomechanical material and

wherein, cyclic illumination of said polymeric photomechanical material by said applied field of selected light energy causes reciprocating bimorphic deformation of said photomechanical body.

10 17. An photomechanical apparatus comprising:

a base;

a polymeric photomechanical body, said polymeric photomechanical body affixed to said base;

15 a light source, and

wherein, illumination of said polymeric photomechanical body by said light source causes a bimorphic deformation of said photomechanical body.

18. The apparatus of Claim 17, wherein said polymeric photomechanical body comprises an illumination surface, said illumination surface comprising a polymeric photosensitive material,

wherein said light source is adapted to generate an illuminating field of selected light energy, and said light source is disposed so as to selectively illuminate said illumination surface, and

wherein, said polymeric photosensitive material has an intrinsic property,

- 5 said intrinsic property having a parametric value, said polymeric photosensitive material adapted such that illumination of said polymeric photosensitive material by a field of selected light energy induces an elastic bulk dimensional change proportional to said parametric value, said parametric value varying along a gradient within said polymeric photosensitive material such that said bulk
- 10 dimensional change comprises a bimorphic deformation of said photomechanical body.

19. The apparatus of Claim 18, wherein said parametric value is the thermal coefficient of linear expansion of said polymeric photosensitive material.

20. The apparatus of Claim 18, wherein said applied field of selected light energy comprises an applied spectrum of light energy selected from the visible and infrared light spectrum.

21. The apparatus of Claim 20, wherein said applied spectrum of light energy comprises a discrete spectrum of light energy selected from the visible and infrared light spectrum.

22. The apparatus of Claim 21, wherein said applied spectrum of light energy comprises a continuous spectrum of light energy selected from the visible and infrared light spectrum.
23. The apparatus of Claim 20, said applied field of selected light energy comprises an applied spectrum of light energy selected from the light spectrum between 300 nm and 10000 nm.
24. The apparatus of Claim 18, wherein said polymeric photosensitive material comprises a photosensitive polyvinylidene fluoride.
25. The apparatus of Claim 24, wherein said photosensitive polyvinylidene fluoride comprises a bimorphic polyvinylidene fluoride film.
26. The apparatus of Claim 24, wherein said bimorphic polyvinylidene fluoride film comprises a polyvinylidene fluoride film coated with a light absorbing material.
27. The apparatus of Claim 18, wherein said photomechanical body comprises a structure formed from said polymeric photosensitive material, said structure selected from the group comprising an elongated plate, a thin sheet, a fiber, and a wound strand.
28. The apparatus of Claim 18, wherein said photomechanical body comprises an elongated plate, said elongated plate comprising a first plate layer of polymeric photosensitive material and a second plate layer of polymeric photomechanical material, each said first and second plate layer having major opposing surfaces,

wherein, one major surface of said first plate layer is affixed upon one major surface of said second plate layer,

wherein, said polymeric photosensitive material comprising said first plate layer has a first plate layer average parametric value of said intrinsic property along said gradient and said polymeric photosensitive material comprising said second plate layer has a second plate layer average parametric value of said intrinsic property along said gradient, and

wherein, said first plate layer average parametric value is greater than said second plate layer average parametric value.

10 29. The apparatus of Claim 18, said light source further adapted to cyclically generate an illuminating field of selected light energy, and

wherein, said photomechanical body is adapted for reciprocating, bimorphic deformation in response to said cyclic illumination of said illumination surface by said applied field of selected light energy.

15 30. A photomechanical actuator, said actuator comprising:

a bimorphic photomechanical body having an illumination surface, said bimorphic photomechanical body comprising at least one photomechanical polymeric material, said bimorphic photomechanical body further comprising an actuator output element;

20 a light source adapted to generate a light output, said light source disposed so as to illuminate said illumination surface with said light output; and

an actuator receiving element, said actuator receiving element adapted to receive the actuator output element,

wherein, said bimorphic photomechanical body is adapted to move said actuator output element by bimorphically deforming in response to illumination of
5 said illumination surface by said light output, and

wherein, said actuator receiving element is adapted so as to transfer the motion of said actuator output element to the actuator receiving element.

31. The apparatus of claim 30, said light source comprising a laser.

32. The apparatus of claim 31, said laser generating a light output in the visible
10 or infrared spectrum.

33. The apparatus of claim 31, said laser generating a light output in the spectrum between 300 nm and 10000 nm and said laser selected from a group of lasers comprising: Ar-ion laser; Nd: YAG lasers; Ti: sapphire lasers; tunable solid state and dye lasers; semiconductor lasers; and carbon dioxide lasers.

15 34. The apparatus of claim 31, said laser comprising an Ar-ion laser.

35. The apparatus of claim 30, the light source comprising:
a light generation device adapted to generate a pulsed light output; and
a light transfer device adapted to direct said light output from said light
generation device to said illumination surface.

20 36. The apparatus of claim 35, said light transfer device comprising a fiber optic cable.

37. The apparatus of claim 36, said bimorphic photomechanical body having a plurality of illumination surfaces, said light transfer device further comprising an optic fiber splitter adapted to split said light output transferred from said light source for transfer to said plurality of illumination surfaces.

5 38. The apparatus of claim 30, said light source comprising a light shaping optical device adapted to focus said light output.

39. The apparatus of claim 38, said light shaping optical device comprising an optical lens.

40. A photomechanical actuator, said actuator comprising:

10 a base;

a bimorphic photomechanical plate affixed to said base, said bimorphic photomechanical plate having at least one illumination surface, said bimorphic photomechanical plate comprising a non-isotropic polymeric photomechanical material;

15 a light source adapted to generate a pulsed light output, said light source disposed so as to illuminate each said illumination surface with at least a portion of said light output; and

wherein, said bimorphic photomechanical body is adapted to move said actuator output element by bimorphic deformation in response to illumination of
20 said illumination surface by said light output, and

wherein, said actuator receiving element is adapted so as to transfer the motion of said actuator output element to the actuator receiving element.

41. The apparatus of claim 40, the light source comprising:

a laser adapted to generate said pulsed light output;

5 a fiber optic cable adapted to direct said light output from said light generation device to said illumination surface; and

an optical system adapted to shape said light output.

42. The apparatus of claim 41, said bimorphic photomechanical plate having a plurality of illumination surfaces, said light transfer device further comprising an

10 optic fiber splitter adapted to split said light output transferred from said light source for transfer to said plurality of illumination surfaces

43. The apparatus of claim 41, said laser adapted to adjustably generate said pulsed light output so as to vary the pulse repetition pattern.

44. The apparatus of claim 41, said laser adapted to adjustably generate said 15 pulsed light output so as to vary the pulse duration.

45. The apparatus of claim 41, said laser adapted to adjustably generate said pulsed light output so as to vary the pulse amplitude.

46. The apparatus of claim 41, said laser adapted to adjustably generate said pulsed light output so as to vary the time delay between pulses in different light outputs.

20 47. The apparatus of claim 41, said laser generating a light output in the visible or infrared spectrum.

48. The apparatus of claim 41, said laser generating a light output in the spectrum between 300 nm and 10000 nm and said laser selected from a group of lasers comprising: Ar-ion laser; Nd: YAG lasers; Ti: sapphire lasers; tunable solid state and dye lasers; semiconductor lasers; and carbon dioxide lasers.

5 49. The apparatus of claim 41, said laser comprising an Ar-ion laser.

50. A photomechanical fluidic pump, said fluidic pump comprising:
a fluidic pump chamber for receiving a fluid, said fluidic pump chamber having a fluid inlet port and a fluid outlet port, said fluidic pump chamber adapted to allow said fluid to flow from said fluid inlet port through said fluidic pump chamber and into said fluid outlet port;

10 a fluidic actuator disposed within said fluidic pump chamber, said fluidic actuator comprising a bimorphic photomechanical body, said bimorphic photomechanical body having an illumination surface, said bimorphic photomechanical body comprising a non-isotropic photomechanical polymeric material;

15 a light source adapted to generate a pulsed light output, said light source disposed so as to illuminate said illumination surface with a portion of said light output; and

20 wherein, said fluidic actuator is adapted to move bimorphically in response to illumination of said illumination surface by said light output, and

wherein, said fluidic actuator is adapted so as to transfer the motion of said fluidic actuator to said fluid.

51. The apparatus of claim 50, photomechanical fluidic pump further comprising a cantilevered beam-resonance chamber fluidic pump, wherein said fluidic pump chamber further comprises a resonance chamber, wherein said fluidic actuator further comprises a bimorphic photomechanical cantilevered beam disposed in said resonance chamber.

52. The apparatus of claim 50, photomechanical fluidic pump further comprising a fluidic diaphragm pump, wherein said fluidic actuator further comprises a bimorphic photomechanical sheet disposed in said fluidic pump chamber.

53. The apparatus of claim 50, the light source comprising:
a laser adapted to generate said pulsed light output;
a fiber optic cable adapted to direct said light output from said light generation device to said illumination surface;

15 an optical system adapted to shape said light output into a coherent beam.

54. The apparatus of claim 53, said bimorphic photomechanical body having a plurality of illumination surfaces, said light transfer device further comprising an optic fiber splitter adapted to split said light output transferred from said light source for transfer to said plurality of illumination surfaces

20 55. The apparatus of claim 53, said laser adapted to adjustably generate said pulsed light output so as to vary the pulse repetition pattern.

56. The apparatus of claim 53, said laser adapted to adjustably generate said pulsed light output so as to vary the pulse duration.

57. The apparatus of claim 53, said laser adapted to adjustably generate said pulsed light output so as to vary the pulse amplitude.

5 58. The apparatus of claim 53, said laser adapted to adjustably generate said pulsed light output so as to vary the time delay between pulses in different light outputs.

59. The apparatus of claim 53, said laser comprising an Ar-ion laser.

60. A photomechanical actuator, said actuator comprising:

a base;

10 a bimorphic photomechanical assembly, said bimorphic photomechanical assembly affixed to said base, said bimorphic photomechanical assembly comprising a plurality of bimorphic photomechanical bodies, each said bimorphic photomechanical assembly comprising a non-isotropic photomechanical polymeric material;

15 a light source adapted to generate a light output, said light source disposed so as to illuminate each said non-isotropic photomechanical polymeric material with at least a portion of said light output, said light source adapted so as to selectively illuminate each said non-isotropic photomechanical polymeric material with at least a portion of said light output; and

20 an actuator output element, said actuator output element affixed to said bimorphic photomechanical assembly; and

wherein, each said bimorphic photomechanical body is adapted to move in response to said selectable illumination by said light output.

61. The apparatus of claim 60, the light source comprising:

a laser adapted to generate said pulsed light output;

5 a fiber optic cable adapted to direct said light output from said light generation device to each said non-isotropic photomechanical polymeric material; and

an optical system adapted to shape said light output into a coherent beam;

an optic fiber splitter adapted to split said light output transferred from a

10 light source for transfer to each said non-isotropic photomechanical polymeric material.

62. The apparatus of claim 61, said laser adapted to adjustably generate a pulsed light output

63. The apparatus of claim 62, said laser adapted to adjustably generate said 15 pulsed light output so as to vary the pulse repetition pattern.

64. The apparatus of claim 62, said laser adapted to adjustably generate said pulsed light output so as to vary the pulse duration.

65. The apparatus of claim 62, said laser adapted to adjustably generate said pulsed light output so as to vary the pulse amplitude.

66. The apparatus of claim 62, said laser adapted to adjustably generate said pulsed light output so as to vary the time delay between pulses in different light outputs.

67. The apparatus of claim 62, said laser comprising an Ar-ion laser.

5 68. A photokinetic apparatus for positioning an executing element, the apparatus comprising:

a light source adapted to generate a light output;

a bimorphic polyvinylidene fluoride film exposed to said light output and adapted to move an actuator output arm in response to said light output; and

10 an actuator output arm connected to said film and adapted to transfer the movement of the output point to an executing element.

69. A photomechanical electronic switch, said photomechanical electronic switch comprising:

an electronic switch disposed in an electrical circuit;

15 a bimorphic photomechanical body, said bimorphic photomechanical body adapted to operate said electronic switch; and

a light source disposed so as to illuminate said bimorphic photomechanical body; and

wherein, illumination of said bimorphic photomechanical body causes a
20 bimorphic deformation of said photomechanical body sufficient to operate said electronic switch.

70. A photomechanical electronic switch, said photomechanical electronic switch comprising:

a bimorphic photomechanical body comprising a non-isotropic photomechanical polymeric material;

5 a light source adapted to generate a light output, said light source disposed so as to illuminate said non-isotropic photomechanical polymeric material with said light output; and

an electronic switch disposed in an electrical circuit, said electronic switch comprising:

10 a switch contact, said switch contact affixed to said bimorphic photomechanical body; and

a circuit contact, said circuit contact adapted to receive said switch contact so as to provide electrical communication across said electronic switch,

15 wherein, said electronic switch is movably adjustable between an open configuration and a closed configuration, said open configuration corresponding to said switch contact disposed so as to interrupt said electrical communication across said electronic switch, and said closed configuration corresponding to said switch contact disposed so as to provide said electrical communication across said 20 electronic switch,

wherein, illumination of said non-isotropic photomechanical polymeric material causes a bimorphic deformation of said photomechanical body sufficient to move said electronic switch from the open configuration to the closed configuration or from the closed configuration to the open configuration.

- 5 71. The apparatus of claim 70, said light source comprising a laser.
72. The apparatus of claim 71, said laser comprising an Ar-ion laser.
73. The apparatus of claim 70, the light source comprising a light transfer device adapted to direct said light output from said light generation device to said non-isotropic photomechanical polymeric material.
- 10 74. The apparatus of claim 73, said light transfer device comprising a fiber optic cable.
75. The apparatus of claim 73 said light transfer device comprising an optical system adapted to shape said light output into a coherent beam.
76. The apparatus of claim 70, said light source comprising a light shaping optical device adapted to focus said light output.
- 15 77. The apparatus of claim 76, said light shaping optical device comprising an optical lens.
78. A photonic switch, said photomechanical photonic switch comprising:
 - a bimorphic photomechanical body comprising a non-isotropic
- 20 photomechanical polymeric material;

a light source adapted to generate a light output, said light source disposed so as to illuminate said non-isotropic photomechanical polymeric material with said light output; and

a photonic switch disposed in an optical circuit, said photonic switch

5 comprising

a light transmitter adapted to generate a signal light beam;

a reflector affixed to said bimorphic photomechanical body, said reflector adapted to reflect said signal light beam; and

10 a light receiver, said receiver adapted to receive said reflected signal

light beam so as to provide optical communication across said photonic switch,

wherein, said photonic switch is movably adjustable between an open configuration and a closed configuration, said open configuration corresponding to said switch reflector disposed so as to interrupt said optical communication across 15 said photonic switch, and said closed configuration corresponding to said reflector disposed so as to provide said optical communication across said photonic switch,

wherein, illumination of said non-isotropic photomechanical polymeric material causes a bimorphic deformation of said photomechanical body sufficient to move said photonic switch from the open configuration to the closed configuration or 20 from the closed configuration to the open configuration.

79. The apparatus of claim 78, said light source comprising a fiber optic transmitter.

80. The apparatus of claim 79, said fiber optic transmitter comprising an infrared semiconductor laser.

5 81. A light beam focusing apparatus, said light beam focusing apparatus comprising:

a bimorphic photomechanical body having an illumination surface, said bimorphic photomechanical body comprising a photomechanical polymeric material;

a light source adapted to generate a light output beam, said light output

10 beam following a beam path, said light source disposed so as to illuminate said illumination surface with said light output beam, said light output beam having a beam cross-sectional area and a beam divergence parameter corresponding to the change in said beam cross-sectional area along said beam path;

wherein, when said illumination surface is not being illuminated, said

15 bimorphic photomechanical body has a flat shape and reflects said light output as a flat mirror without changing the beam divergence parameter of said beam;

wherein, illumination of said illumination surface by said applied field of selected light energy causes a bimorphic deformation of said photomechanical body sufficient to change said beam divergence parameter of said output beam.

20 82. The apparatus of claim 81, said light source comprising a laser.

83. The apparatus of claim 82, said laser adapted to operate in a spectrum between 300 nm and 10000 nm.